

## CLAIMS

1. A semiconductor device comprising:
  - a first semiconductor layer that is formed from a first semiconductor material;
  - 5 a second semiconductor layer that is formed from a second semiconductor material on the first semiconductor layer;
    - a two-dimensional carrier that is formed within the first semiconductor layer and in the vicinity of an interface between the first semiconductor layer and the second semiconductor layer;
- 10 a first concave portion that is formed extending from a primary surface of the second semiconductor layer that faces the interface between the first semiconductor layer and the second semiconductor layer as far as the interface;
  - a first electrode that is formed on a bottom surface and side surface of the first concave portion and that forms a Schottky junction between the first and second semiconductor layers; and
  - 15 a second electrode that is formed in an area of the second semiconductor layer that is located away from the first electrode and that forms a low resistance contact with the second semiconductor layer.
- 20 2. The semiconductor electrode according to claim 1, wherein the first electrode is formed so as to extend from the primary surface of the second semiconductor layer as far as the two-dimensional carrier, or is formed so as to face the two-dimensional carrier and separated therefrom by a distance that allows a quantum mechanical tunnel effect to be obtained.

3. A semiconductor device comprising:
  - a first semiconductor layer that is formed from a first semiconductor material;
  - a second semiconductor layer that is formed from a second semiconductor material on the first semiconductor layer;
- 5 a third semiconductor layer that is sandwiched between the first semiconductor layer and the second semiconductor layer and that is formed having a thickness that allows a quantum mechanical tunnel effect to be obtained;
  - a two-dimensional carrier that is formed within the first semiconductor layer and on the third semiconductor layer side of the first semiconductor layer;
- 10 a first concave portion that is formed extending from a primary surface of the second semiconductor layer that faces the interface between the third semiconductor layer and the second semiconductor layer as far as the interface;
  - a first electrode that is formed on a bottom surface and side surface of the first concave portion and that forms a Schottky junction between the first and second semiconductor layers; and
- 15 a second electrode that is formed in an area of the second semiconductor layer that is located away from the first electrode and that forms a low resistance contact with the second semiconductor layer.

  

- 20 4. The semiconductor device according to claim 1, wherein there is further provided a second concave portion that is formed extending from the primary surface of the second semiconductor layer as far as the interface between the first semiconductor layer and the second semiconductor layer, and wherein the second electrode is formed on a bottom surface and side surface of the second concave portion.

5. The semiconductor device according to claim 3, wherein there is further provided a second concave portion that is formed extending from the primary surface of the second semiconductor layer as far as the interface between the third semiconductor layer and the second semiconductor layer, and wherein the second electrode is formed on 5 a bottom surface and side surface of the second concave portion.

6. The semiconductor electrode according to claim 1 or claim 3, wherein the second electrode is formed so as to extend from the primary surface of the second semiconductor layer as far as the two-dimensional carrier.

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7. The semiconductor device according to claim 2, wherein there is further provided a second concave portion that is formed extending from the primary surface of the second semiconductor layer as far as the two-dimensional carrier, and wherein the second electrode is formed on the bottom surface and side surface of the second concave 15 portion, and is formed so as to extend from the primary surface of the second semiconductor layer as far as the two-dimensional carrier.

8. The semiconductor device according to claim 1 or claim 3, wherein, when viewed from a perpendicular direction relative to the primary surface, the second 20 electrode is formed so as to sandwich and face the first electrode.

9. The semiconductor device according to claim 1 or claim 3, wherein, when viewed from a perpendicular direction relative to the primary surface, the second electrode is formed so as to surround the first electrode.

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10. The semiconductor device according to claim 1 or claim 3, wherein the first electrode is also formed on the primary surface of the second semiconductor layer that surrounds the first concave portion.